

## CLAIMS

1        1. A supermolecular structure comprised of a host material and impurities such  
2        that the positions of component atoms are substantially fixed, to impart substantially  
3        predictable properties to the structure, the structure also being described by the for-  
4        mula:

5                     $H_A \Sigma X_{ia}$

6        wherein:

7                    H defines the host material;

8                    A is a number representing the number of host atoms in the structure;

9                    X defines the  $i^{\text{th}}$  impurity; and

10                  a defines the quantity of the  $i^{\text{th}}$  impurity.

1        2. A pn junction formed from the supermolecular structure of claim 1.

1        3. The pn junction of claim 2 further comprising:

2                  an insulating substrate on which the supermolecular structure is dis-  
3                  posed; and

4                  contact electrodes connected to the supermolecular structure so that the  
5                  pn junction forms a stand-alone device.

1           4. A bipolar cell formed from the supermolecular structure of claim 1.

1           5. The bipolar cell of claim 4 further comprising:

2           an insulating substrate on which the supermolecular structure is dis-  
3           posed; and  
4           contact electrodes connected to the supermolecular structure so that the  
5           bipolar cell forms a stand-alone device.

1           6. A single charge oscillator array comprising a plurality of electrostatically  
2           coupled supermolecular structures, each structure further comprising a host material  
3           and impurities such that the positions of component atoms are substantially fixed to  
4           impart substantially predictable properties to the structure, each structure also being  
5           described by the formula:

6            $H_A \Sigma X_{ia}$

7           wherein:

8           H defines the host material;

9           A is a number representing the number of host atoms in the structure;

10          X defines the  $i^{\text{th}}$  impurity; and

11          a defines the quantity of the  $i^{\text{th}}$  impurity.

1       7. A single-dopant pn junction comprising:  
2           a host structure;  
3           a single donor atom disposed at a first side of the host structure; and  
4           a single acceptor atom disposed at a second side of the host structure,  
5           the second side being opposite the first side, the single donor atom and single  
6           acceptor atom being positioned so that a single dipole is created within the host  
7           structure.

1       8. The single-dopant pn junction of claim 7 further comprising:  
2           an insulating substrate on which the host structure is disposed; and  
3           contact electrodes connected to the host structure so that the single-  
4           dopant pn junction forms a stand-alone device.

1       9. A single-dopant bipolar cell comprising:  
2           a host structure;  
3           a pair of atoms of a first type disposed so that a single atom of the pair  
4           resides at each of two opposing sides of the host structure; and  
5           a single atom of a second type disposed between the atoms of the first  
6           type within the host structure so that two asymmetrical potential wells, sepa-  
7           rated by a barrier, are formed within the host structure.

1        10. The single-dopant bipolar cell of claim 9 wherein the first type of atom is an  
2        acceptor and the second type of atom is a donor.

1        11. The single-dopant bipolar cell of claim 9 wherein the first type of atom is a  
2        donor and the second type of atom is an acceptor.

1        12. A semiconductor device comprising:  
2                an insulating substrate;  
3                a host structure disposed upon the insulating substrate;  
4                a pair of atoms of a first type disposed so that a single atom of the pair  
5        resides at each of two opposing sides of the host structure;  
6                a single atom of a second type disposed between the atoms of the first  
7        type within the host structure so that two asymmetrical potential wells, sepa-  
8        rated by a barrier, are formed within the host structure; and  
9                contact electrodes connected to the host structure.

1        13. The semiconductor device of claim 12 wherein the first type of atom is an  
2        acceptor and the second type of atom is a donor.

1       14. The semiconductor device of claim 12 wherein the first type of atom is a  
2       donor and the second type of atom is an acceptor.

1       15. A single charge oscillator array comprising a plurality of electrostatically  
2       coupled, single-dopant bipolar cells, each cell further comprising:  
3               a host structure;  
4               a pair of atoms of a first type disposed so that a single atom of the pair  
5       resides at each of two opposing sides of the host structure; and  
6               a single atom of a second type disposed between the atoms of the first  
7       type within the host structure so that two asymmetrical potential wells, sepa-  
8       rated by a barrier, are formed within the host structure.

1       16. A semiconductor oscillator comprising:  
2               an insulating substrate;  
3               a single charge oscillator array disposed upon the insulating substrate;  
4               contact electrodes connected to the array; and  
5               a thermal energy supply system for maintaining an operating tempera-  
6       ture of the array at least as high as a threshold temperature.

1           17. The semiconductor oscillator of claim 16 wherein the single charge oscilla-  
2        tor array further comprises a plurality of electrostatically coupled supermolecular  
3        structures, each structure further comprising a host material and impurities such that  
4        the positions of component atoms are substantially fixed to impart substantially pre-  
5        dictable properties to the structure, each structure also being described by the formula:

6                    $H_A \Sigma X_{ia}$

7           wherein:

8           H defines the host material;

9           A is a number representing the number of host atoms in the structure;

10          X defines the  $i^{\text{th}}$  impurity; and

11          a defines the quantity of the  $i^{\text{th}}$  impurity.

1           18. The semiconductor oscillator of claim 16 wherein the single charge oscilla-

2        tor array further comprises a plurality of electrostatically coupled, single-dopant bipolar

3        cells, each cell comprising:

4           a host structure;

5           a pair of atoms of a first type disposed so that a single atom of the pair

6        resides at each of two opposing sides of the host structure; and

7           a single atom of a second type disposed between the atoms of the first

8        type within the host structure so that two asymmetrical potential wells, sepa-

9        rated by a barrier, are formed within the host structure.

## 1        19. Apparatus for supplying oscillations comprising:

2                means for supplying thermal energy to maintain an operating tempera-  
3                ture of the apparatus at least as high as a threshold temperature;  
4                means for generating coherent oscillations in response to the thermal  
5                energy;  
6                means for insulating and supporting the means for generating; and  
7                means for connecting the apparatus to external circuitry, the means for  
8                connecting connected to the means for generating.

## 1        20. A method of fabricating a single-dopant, bipolar cell on a substrate of a

2        semiconductor material, the method comprising the steps of:

3                placing a single three-atom set of dopants on the substrate;  
4                growing an epitaxial film of the semiconductor material over the set of  
5                dopants and the substrate; and  
6                passivating the cell with at least one monolayer.

## 1        21. The method of claim 20 wherein the three-atom set of dopants is placed by

2        a proximity probe manipulation technique.

1        22. A method of fabricating a plurality of single-dopant bipolar cells on a sub-  
2        strate of a semiconductor material, the method comprising the steps of:

3                placing two or more single three-atom sets of dopants on the substrate;  
4                growing an epitaxial film of the semiconductor material over the sets of  
5        dopants and the semiconductor substrate;  
6                producing a pattern at the surface of the epitaxial film, the pattern defin-  
7        ing a shape for the cells; and  
8                passivating the plurality of single-dopant bipolar cells with at least one  
9        monolayer.

1        23. The method of claim 22 wherein the three-atom sets of dopants are placed  
2        by a proximity probe manipulation technique.

1        25. A method of fabricating a single-dopant bipolar cell by forming a vertical,  
2        three-atom set of dopants, the cell being formed on a substrate of semiconductor ma-  
3        terial, the method comprising the steps of:

4                placing a first atom of a first type on the substrate;  
5                growing a first epitaxial film of the semiconductor material over the first  
6        atom and the substrate;  
7                placing a single atom of a second type atop the first epitaxial film;

8                   growing a second epitaxial film of the semiconductor material over the  
9                   single atom of the second type and the first epitaxial film;  
10                  placing a second atom of the first type atop the second epitaxial film so  
11                  that the three-atom set is formed;  
12                  growing a third epitaxial film of the semiconductor material over the sec-  
13                  ond atom of the first type and the second epitaxial film; and  
14                  passivating the cell with at least one monolayer.

1                  26. The method of claim 25 wherein the first atom of the first type, the single  
2                  atom of the second type, and the second atom of the first type are all placed by a  
3                  proximity probe manipulation technique.

1                  27. A method of fabricating an plurality of single-dopant bipolar cells by forming  
2                  vertical, three-atom sets of dopants, the cells being formed on a substrate of semicon-  
3                  ductor material, the method comprising the steps of:

4                  placing two or more first atoms of a first type on the substrate;  
5                  growing a first epitaxial film of the semiconductor material over the first  
6                  atoms of the first type and the substrate;  
7                  placing a plurality of single atoms of a second type atop the first epitaxial  
8                  film;

9                   growing a second epitaxial film of the semiconductor material over the  
10                single atoms of the second type and the first epitaxial film;  
11                placing a plurality of second atoms of the first type atop the second epi-  
12                taxial film so that three-atom sets are formed;  
13                growing a third epitaxial film of the semiconductor material over the sec-  
14                ond atoms of the first type and the second epitaxial film;  
15                producing a pattern at the surface of the third epitaxial film, the pattern  
16                defining a shape for the cells; and  
17                passivating the plurality of single-dopant bipolar cells with at least one  
18                monolayer.

1                28. The method of claim 27 wherein the first atoms of the first type, the single  
2                atoms of the second type, and the second atoms of the first type are all placed by a  
3                proximity probe manipulation technique.